GIS_EM (Geographic Information System for Environmental Monitoring) - A software implemented at Paulínia Refinery (REPLAN) for management of environmental data

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Abstract - This paper presents the computational program called GIS_EM (Geographic Information System for Environmental Monitoring), a software devised to manage geographic information for monitoring soil, surface and ground water, developed for use in the Health, Safety and Environment Division of Paulínia Refinery (REPLAN). This program enables registering and management of alphanumeric information pertaining to specific themes such as drilling performed for sample collection and for installation of monitoring wells, geophysical and other tests, results of chemical analyses of soil, surface and groundwater, as well as reference values providing orientation for soil and water quality, such as USEPA, Dutch List, among others. Management of such themes is performed by means of alphanumeric search tools, with specific filters and, in the case of spatial search, through the selection of spatial elements (themes) in map view. Documents existing in digital form, such as reports, photos, maps, may be registered and managed in the network environment. As the system centralizes information generated upon environmental investigations, it expedites access to and search of documents produced and stored in the network environment, minimizing search time and the need to file printed documents.

Keywords - management of environmental information, computational program, spatial elements, search tools.

INTRODUCTION

In the last decades, anthropogenic activities have been causing an impact on the physical environment (soil/water/air). Since the 70s, world concern with environmental questions involving pollution of ground and surface waters, rocky soil/substrate and air has been growing continuously. One consequence of such concern is the development of countless research activities related to the subject of environmental contamination, carried out by companies, universities, environmental agencies and industry in general.

Among the activities developed by man that may generate contamination of the physical environment, we mention here the activities of petroleum exploration, production and processing, as well as storage and transportation of petroleum and its byproducts.

In recent years REPLAN (the biggest petroleum refinery of Brazil) has been intensifying its environmental investigations aiming at identifying possible environmental impacts generated along its 33 years of operation. The main object of such research is to know the hydrogeological characteristics of the ground where it is installed, possible interactions of its activities with the elements of physical environment (soil/water/air), always trying to solve problems of contamination created in the past as well as minimizing future impacts.

Such investigations have produced a great volume of information, both in digital format and in hard copy, which has caused the necessity to use a system to register existing data in a program enabling access by several users through a local network.

The Geographic Information System (GIS) has been widely used in the management of information of varied nature on a worldwide scale.

Software GIS_EM (Geographic Information System for Environmental Monitoring) has been developed for use in REPLAN's Health, Safety and Environment Division, focused on management of geographic information for monitoring soil, surface and ground water.

This program enables registering and management of alphanumeric information pertaining to specific themes such as drilling performed for sample collection and for installation of monitoring wells, geophysical and other tests. To manage such themes, the system has alphanumeric searching tools, with specific filters and spatial search, through selection of spatial elements (themes) in map view. The system also enables registering and management of alphanumeric information from results of chemical analyses of soil, surface and ground water, as well as reference values providing orientation for soil and water quality, such as those of USEPA, Dutch List, among others.

Documents existing in digital form, such as reports, photos, and maps, related or not to the spatial elements of the project themes (drillings, wells, areas, etc.), may be registered and managed in the network environment.

SOFTWARE ARCHITECTURE

Functionalities available in GIS_EM system have been implemented by means of development tools Microsoft Visual Studio.NET and ESRI ArcGis Arc Objects 9.0, aiming at personalizing GIS ESRI ArcGis 9.0 software to a client/server environment. Development standard adopted follows the methodology of development in tiers (n-tiers), called MVC (*Model View Controller*), recommended by the international leader of software design, Design Partners. The geographic database has been modeled by using the *CASE Erwin* tool and implemented in ESRI Personal Geo database.

RESULTS

GIS_EM program has been prepared envisaging meeting the requirements of usability, reliability and safety. Usability has been ensured by the practicality of the system, through friendly interfaces with graphic elements, such as menus, buttons, text boxes that are driven in a sequential form, and the help module, which makes handling easy and pleasant. Reliability has been tested concerning frequency and severity of system faults, so that information is registered and presented without faults or alterations. Likewise, safety has been ensured through verification of the integrity, privacy and authenticity of the data registered in the system, even in a network environment.

System functionalities enable:

- ✓ the storage of alphanumeric and spatial information pertaining to specific themes, such as drilling performed for sample collection and for installation of monitoring wells, geophysical and other tests;

- ✓ the storage of alphanumeric information pertaining to the register of results of chemical analyses of soil and ground & surface water;

- ✓ the storage of alphanumeric information from reference values providing orientation, such as those of USEPA, Dutch List, among others.

- ✓ registering and managing information from documents existing in the network environment in digital form, related or not to the spatial elements of the project themes such as drillings, wells, areas, etc;

- ✓ registering, according to selected themes, and searching data through specific filters, such as date or date interval, subject, area or format of document or, also, through a combination of these filters, whereby the desired information is selected;

- ✓ viewing, as a product of the search, documents available through lists, with information registered and requested through filters. Data search interfaces enable to view information registered through lists and reports and, in the case of spatial elements, through maps;

- ✓ searching results pertaining to the historic evolution of concentrations obtained in water samples, anomalous values and other information related to results of chemical analyses in soil and water samples, which may be viewed in the form of charts.

Presentation screen (Figure 1) shows the register interfaces, on the left side, and the satellite photo of REPLAN, on the right side, where registered themes are viewed.

Data register related to a given theme is made through specific interfaces that enable the registration of their attributes. Figures 2a and 2b illustrate, as an example, the register of the attributes related to the theme "wells". Figure 3 shows the register interface for the result of chemical analysis in oil sample. Figure 4 presents the interface for the register of reference values providing orientation (standard for obtaining concentrations of chemical species). Figure 5 shows an example of the representation of punctual elements, in this case wells and drillings, and linear elements (section) in a selected area, in this case, located in the "Mina de Argila" (Clay Mine) area (REPLAN). Figure 6 illustrates a chart search interface in soil samples while Figure 7 presents, as a search product, a chart with results of chemical analyses performed in samples of ground water collected in well ATI PM 1 (historic evolution) for metal Aluminum, in relation to the orientation limit stipulated by the environmental agency;
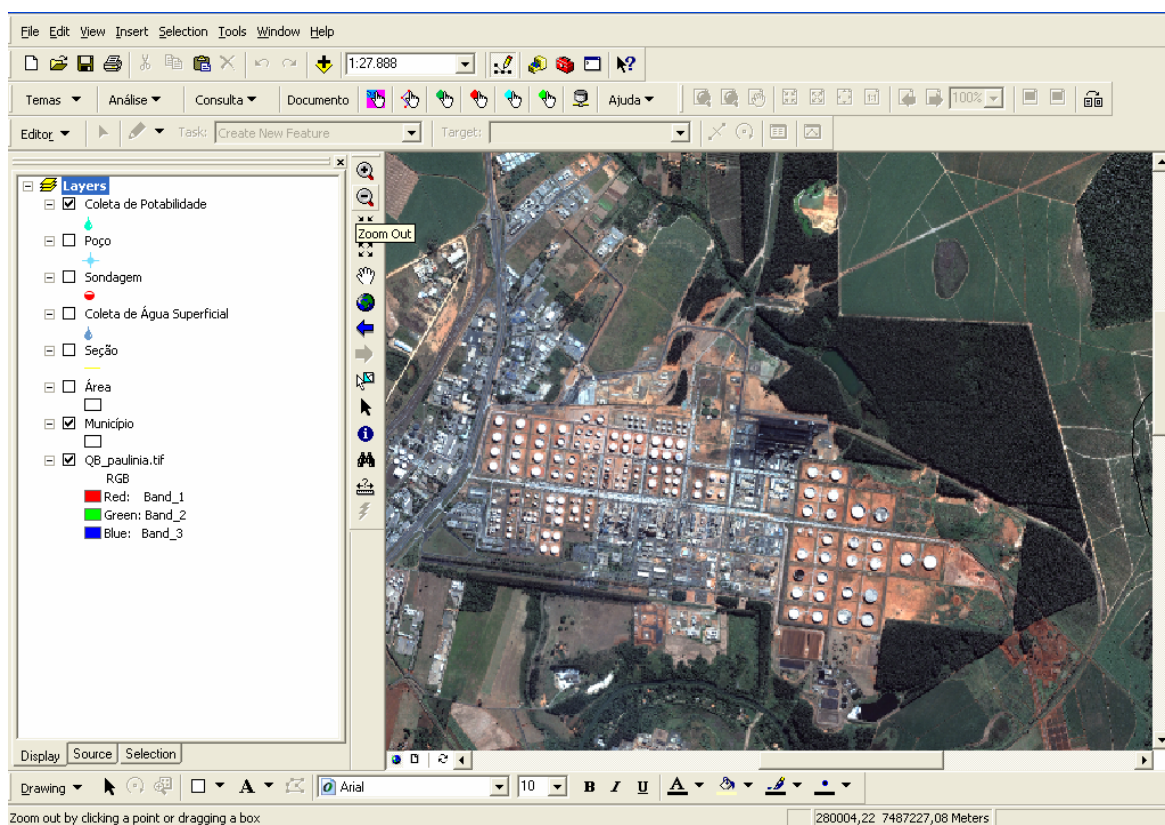
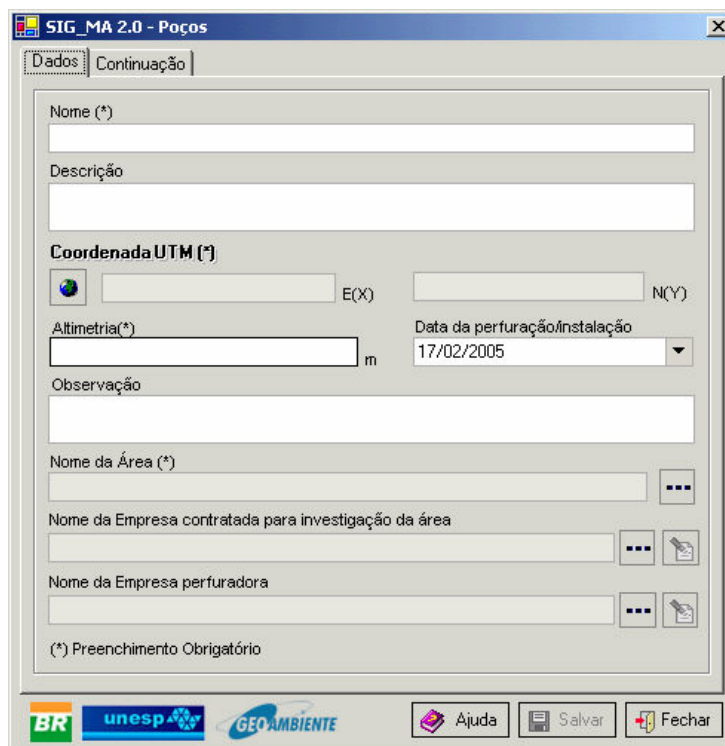Figure 1 - Presentation screen of GIS_EM program

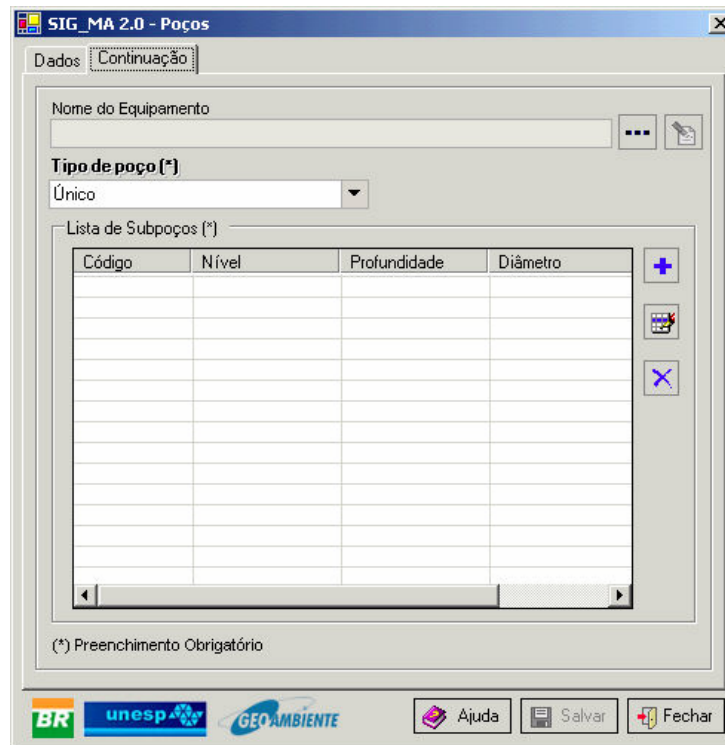Figure 2a - Interface of the register of the well theme.

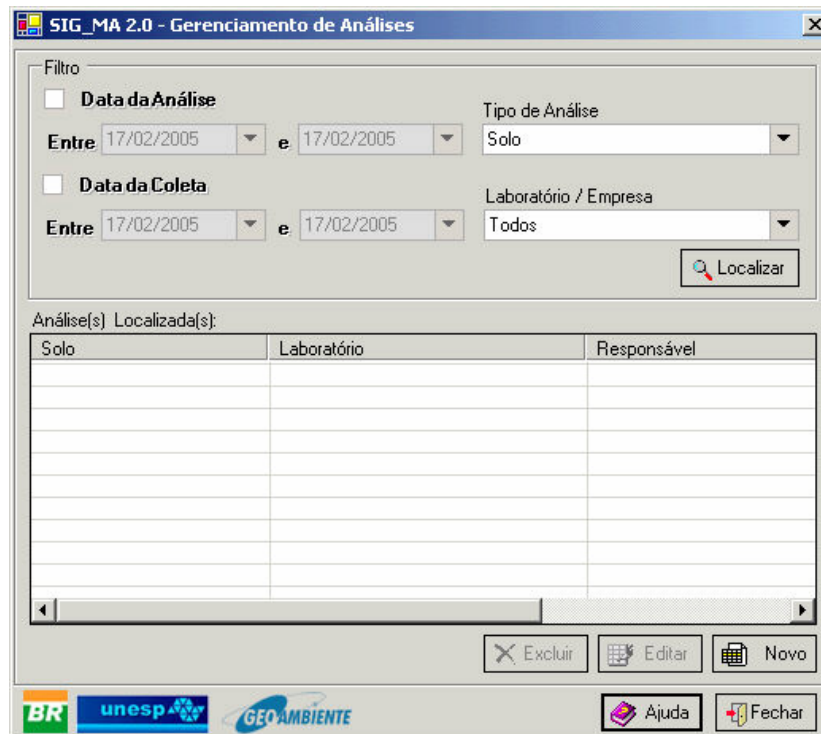Figure 2b - Interface of the register of the well theme.

Figure 3 - Interface of the register of chemical analyses in soil sample.
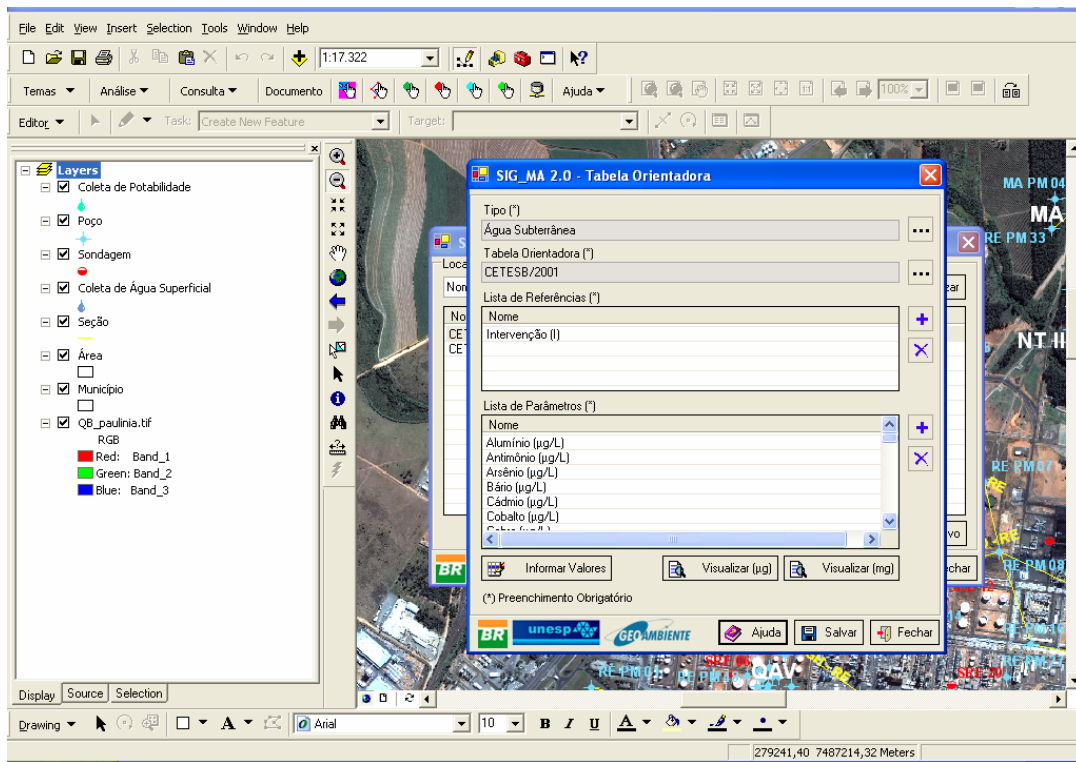
Figure 4 - Interface of the register of reference values providing orientation on the quality of ground water according to CETESB standard.
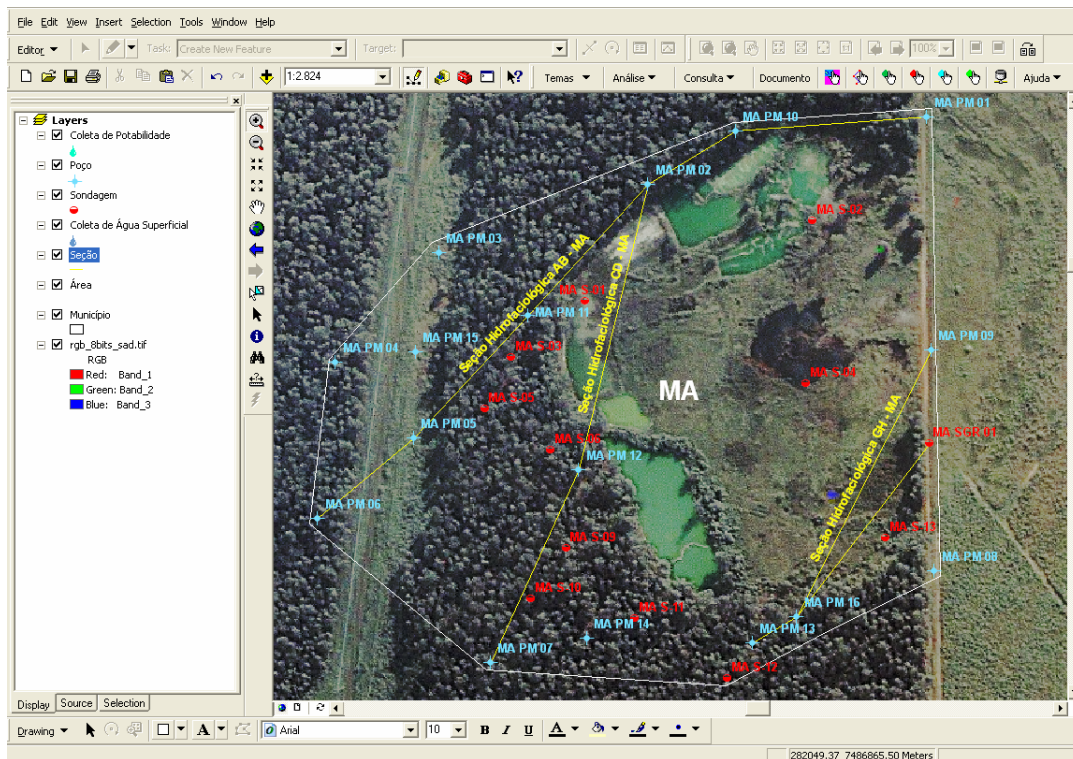

Figure 5 - Viewing screen for the punctual elements, wells (blue), drillings (red) and linear elements, sections (yellow).
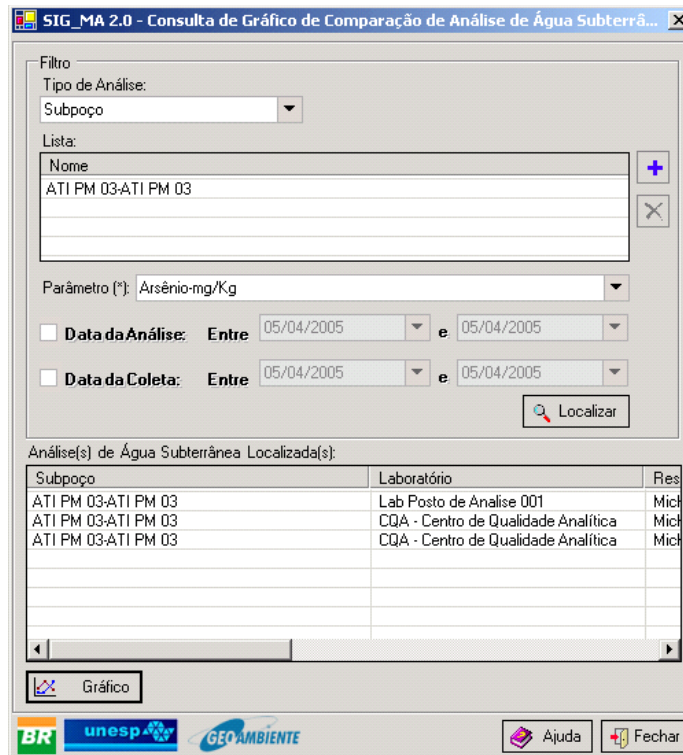
Figure 6 - Interface of the register of chemical analyses to generate a chart.
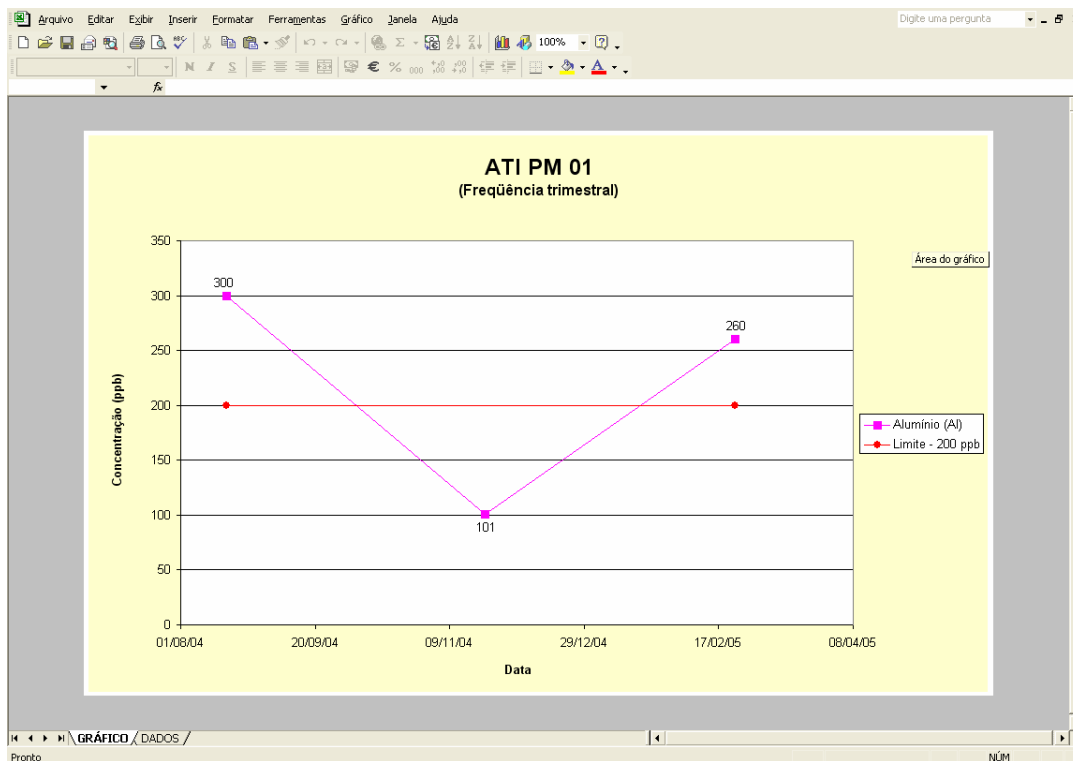

Figure 7 - Chart viewing screen illustrating the result of chemical analysis performed to determine the aluminum content in water sample (pink) in relation to the limit value providing orientation stipulated by environmental agency CETESB (2001) (red).

CONCLUSIONS

The system proved to be efficient and practical in registering and managing the environmental information available. Because of the fact that it centralizes information generated upon environmental investigations, it expedites access to documents produced and stored in the network environment, minimizing the search time and the need to file printed documents.

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